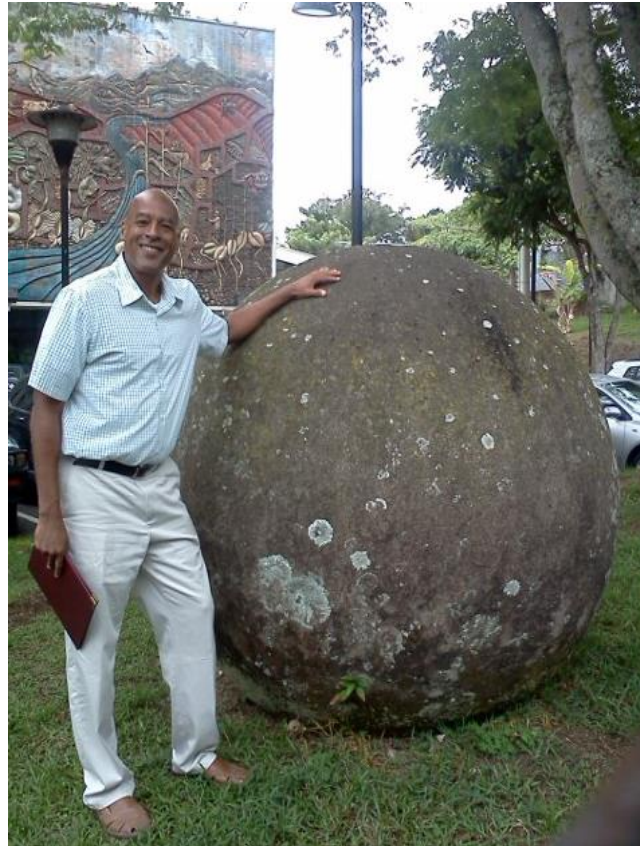


# Natural Physics!

November 5, 2015



by  
LeRoy Larry



Johannes Kepler

### Kepler's laws of planetary motion

The orbit of a planet is an ellipse with the Sun at one of the two foci. 1609

A line segment joining a planet and the Sun sweeps out equal areas during equal intervals of time. 1609

The square of the orbital period of a planet is proportional to the cube of the semi-major axis of its orbit. 1619

$$T^2 \propto R^3$$

$$T \propto R^{3/2}$$

$$V \propto R/T \propto R/R^{3/2} \propto 1/R^{1/2}$$

momentum = mass x velocity

angular momentum = mass x velocity x radius

# Pluto pulled by gravity

$$F = G \times M1 \times M2 / R^{**2}$$

M1 = Mass of Pluto

M2 = Mass of Saturn

R = Distance of Pluto from Saturn

G = Universal Constant

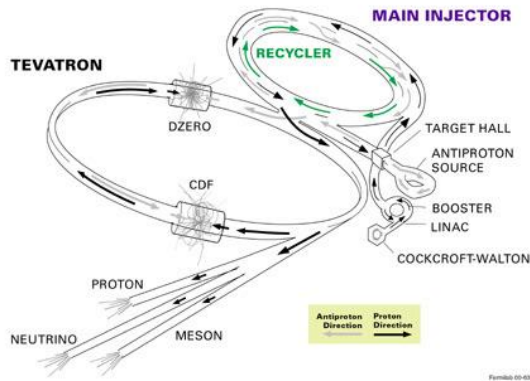
# Fermilab Tevatron



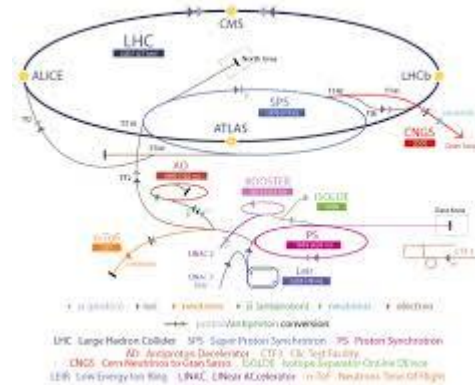
# CERN Large Hadron Collider (LHD)



FERMILAB'S ACCELERATOR CHAIN



CERN Accelerator Complex

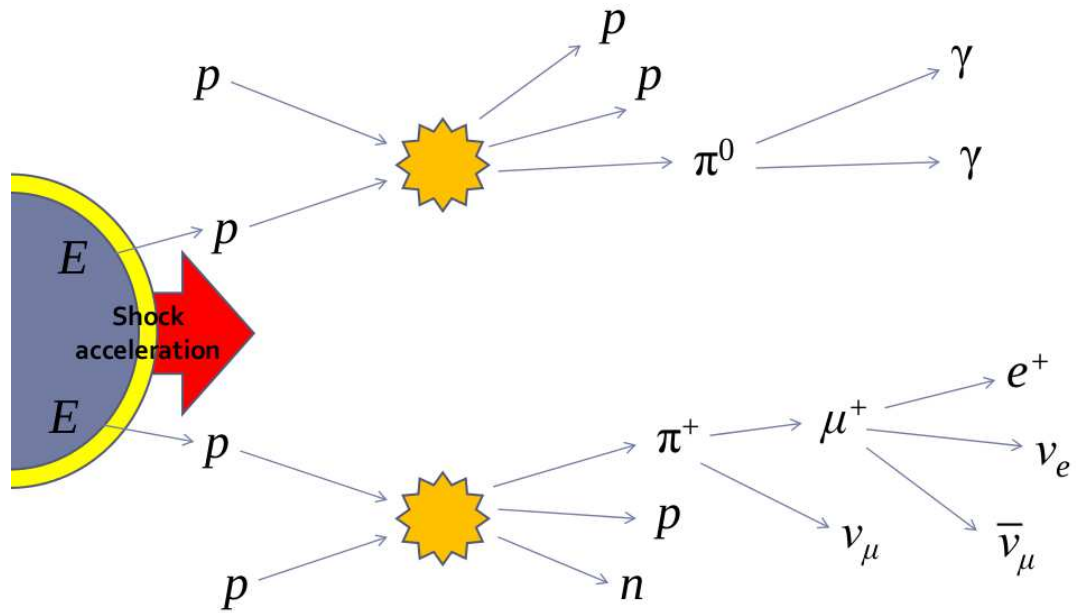


circumference = 4.26 miles = 6.86 km

1 TeV

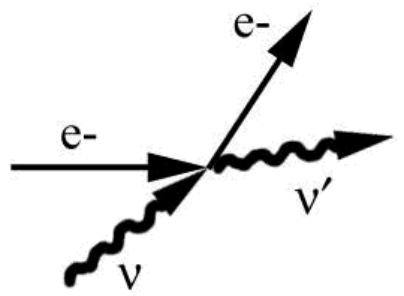
circumference = 17 miles = 27 km

13 TeV



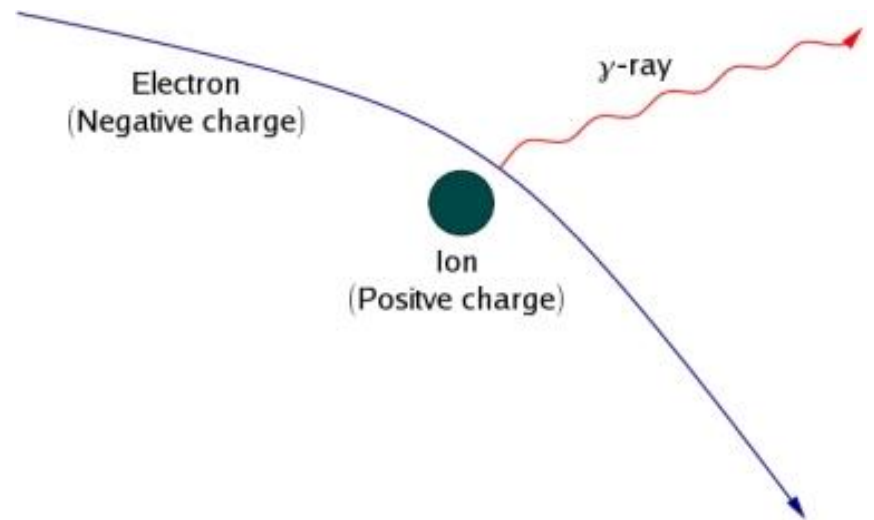
Neutral pion decay

Inverse Compton scattering

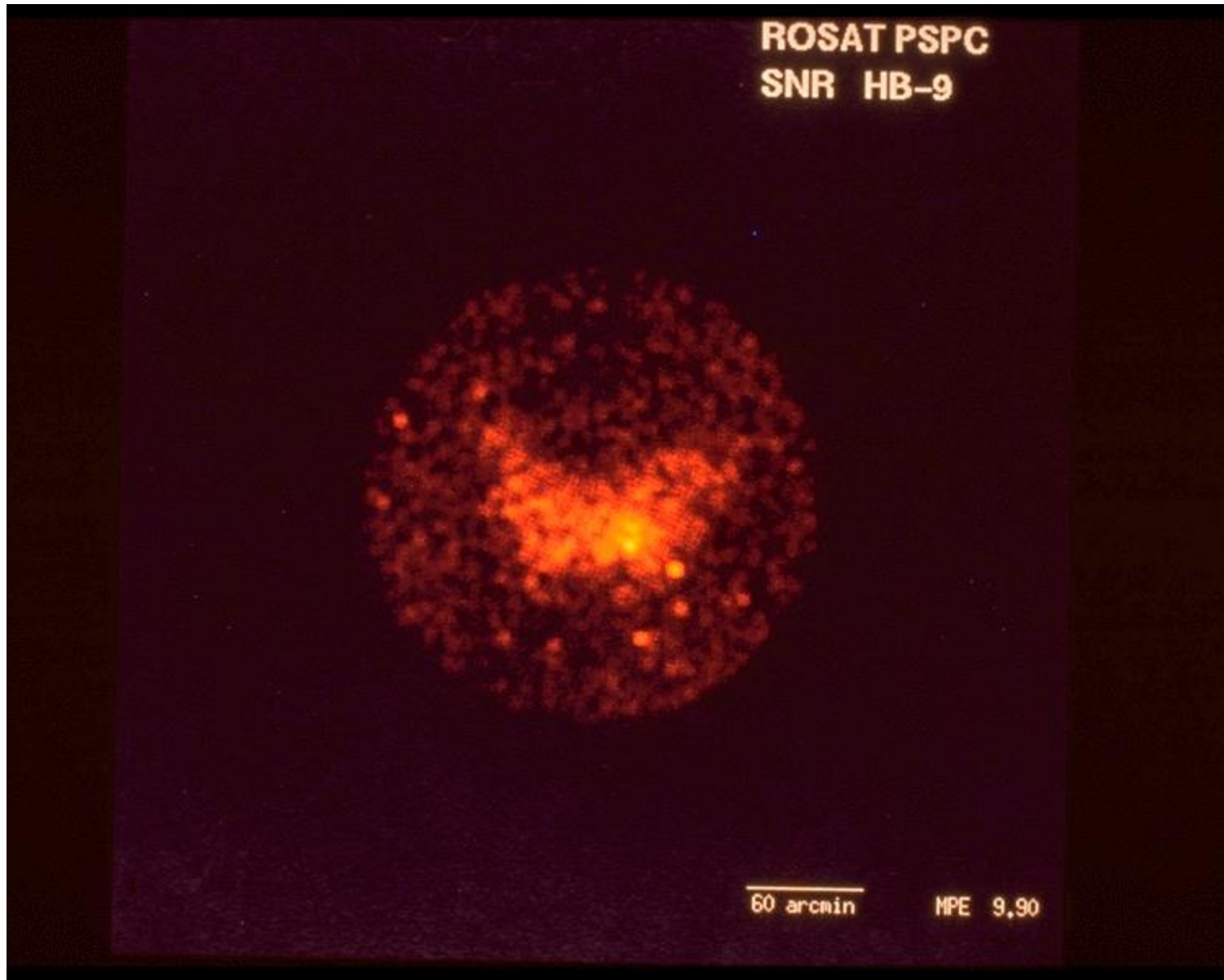


$\nu' > \nu$   
 High energy  $e^-$  initially  
 $e^-$  loses energy

Bremsstrahlung

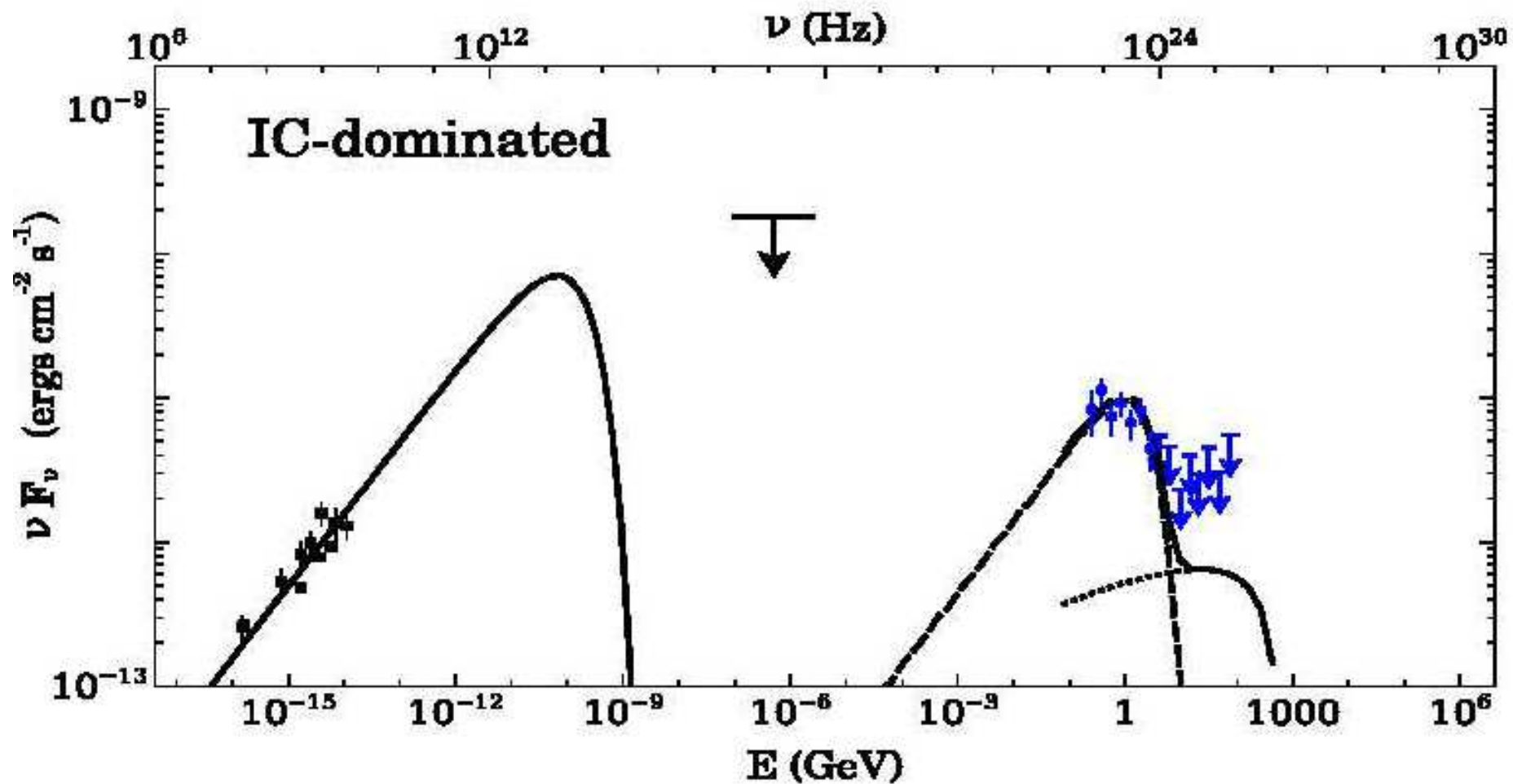


# Supernova Remnant (SNR) HB9



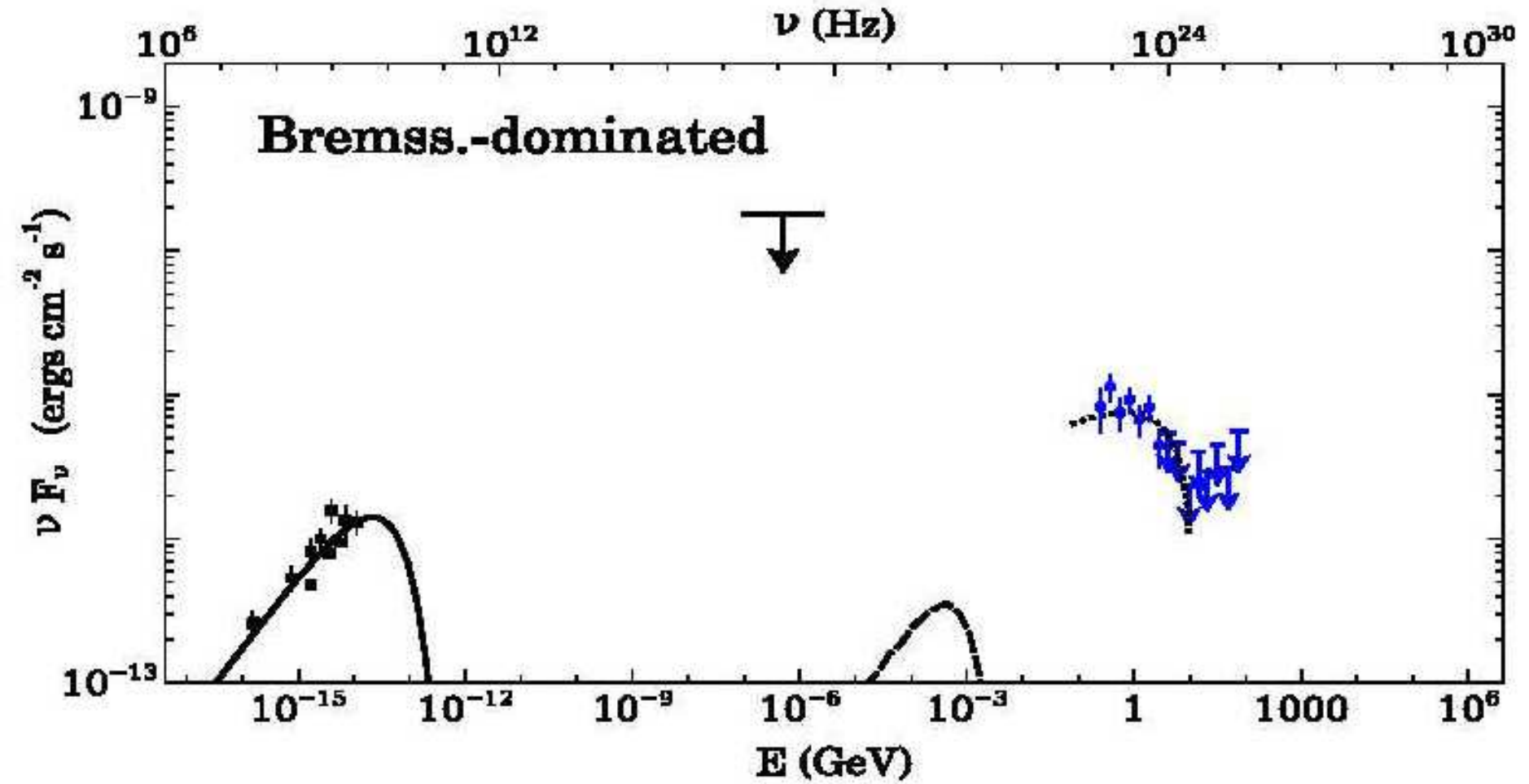
4,000 - 7,000 years      6500 light years (ly) = 39,000 trillion miles = 58,500 trillion km

# HB9 Spectral Energy Distribution (SED)

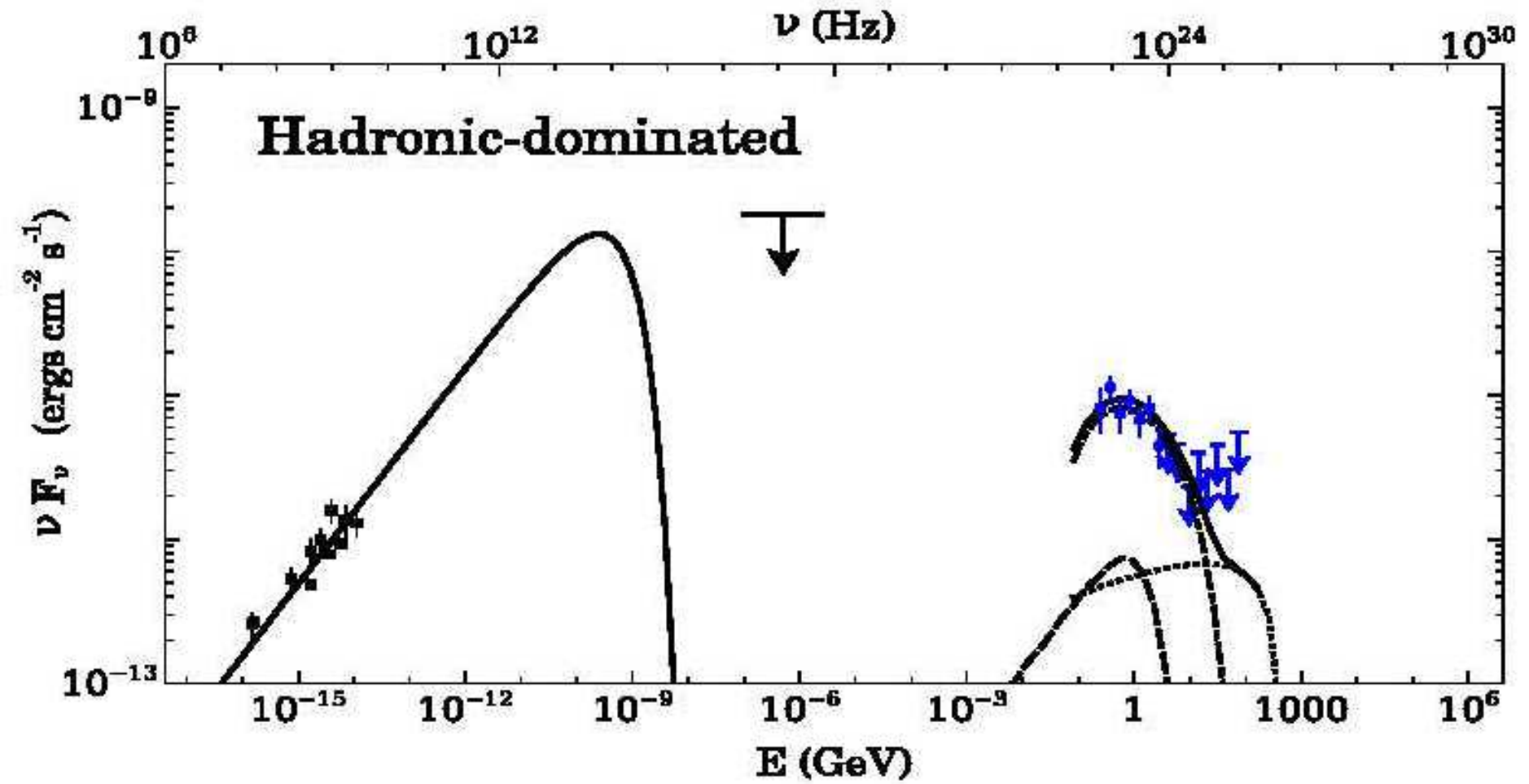




# HB9 SED

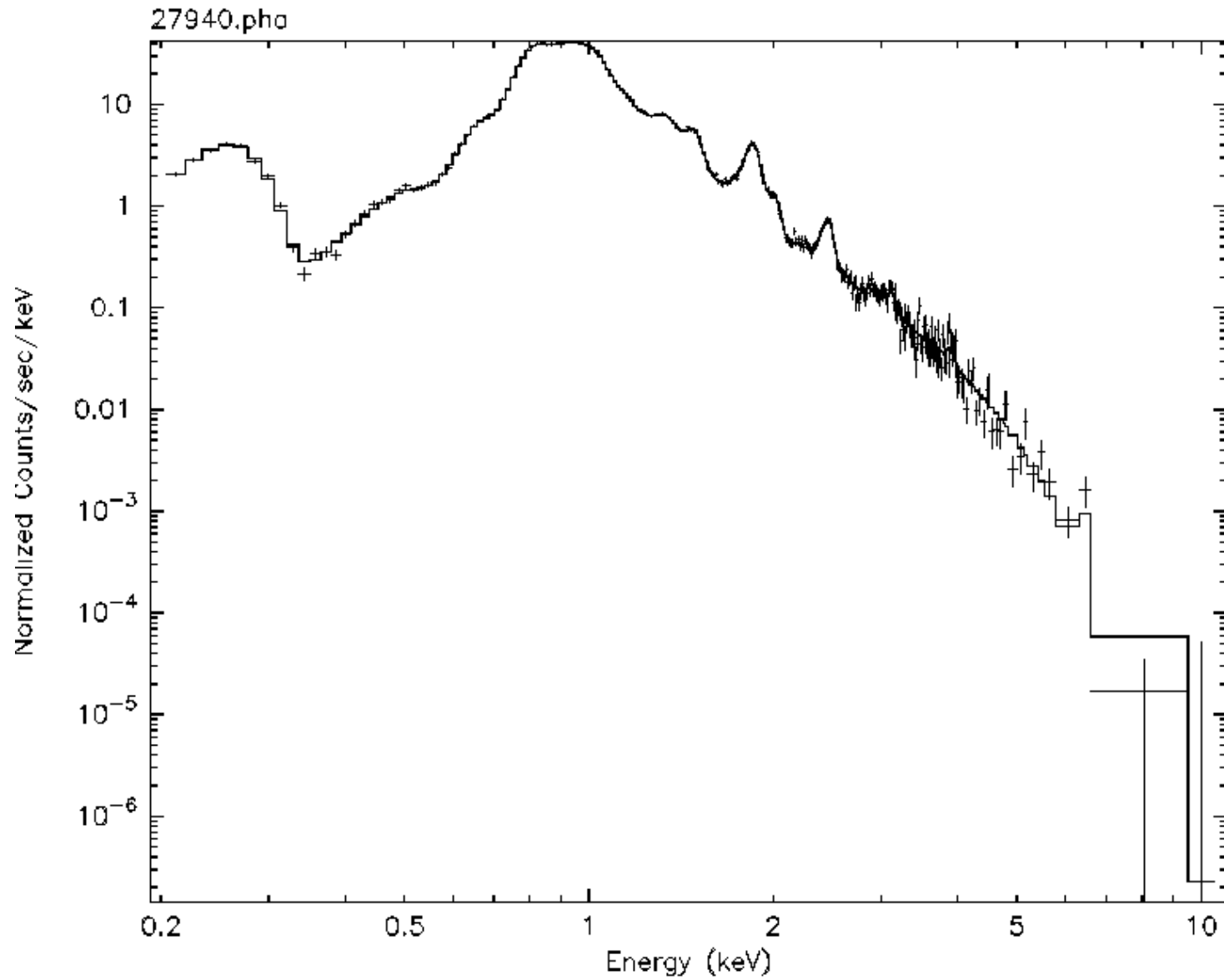


# HB9 SED



# HB9 X-ray Spectrum

Simulated ACIS



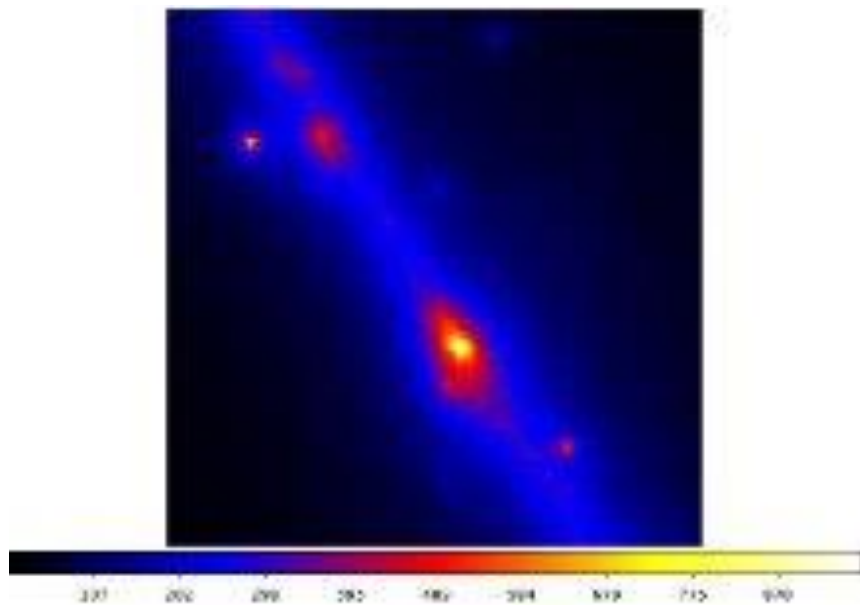
SNR G1.9 + 0.3



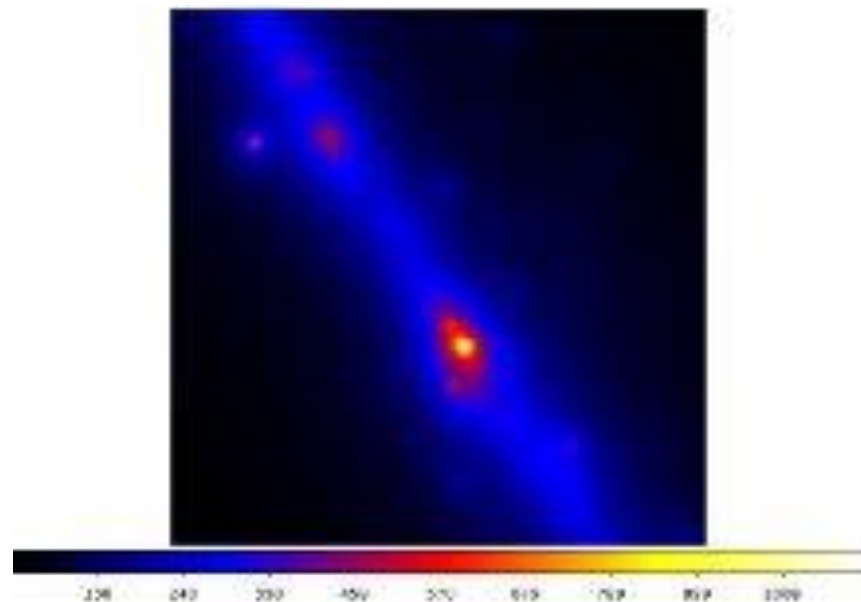
150 - 220 years

26,000 ly = 156,000 trillion miles = 234,000 trillion km

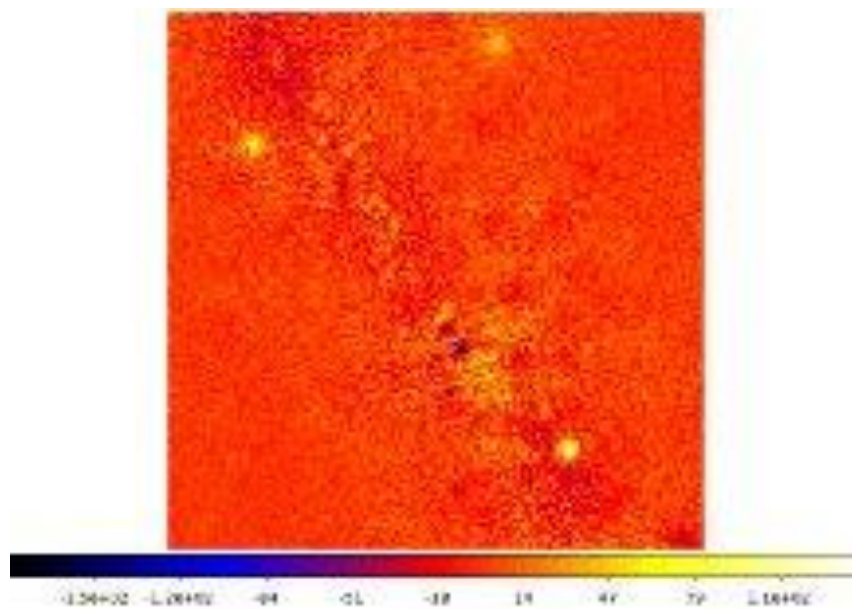
Counts map



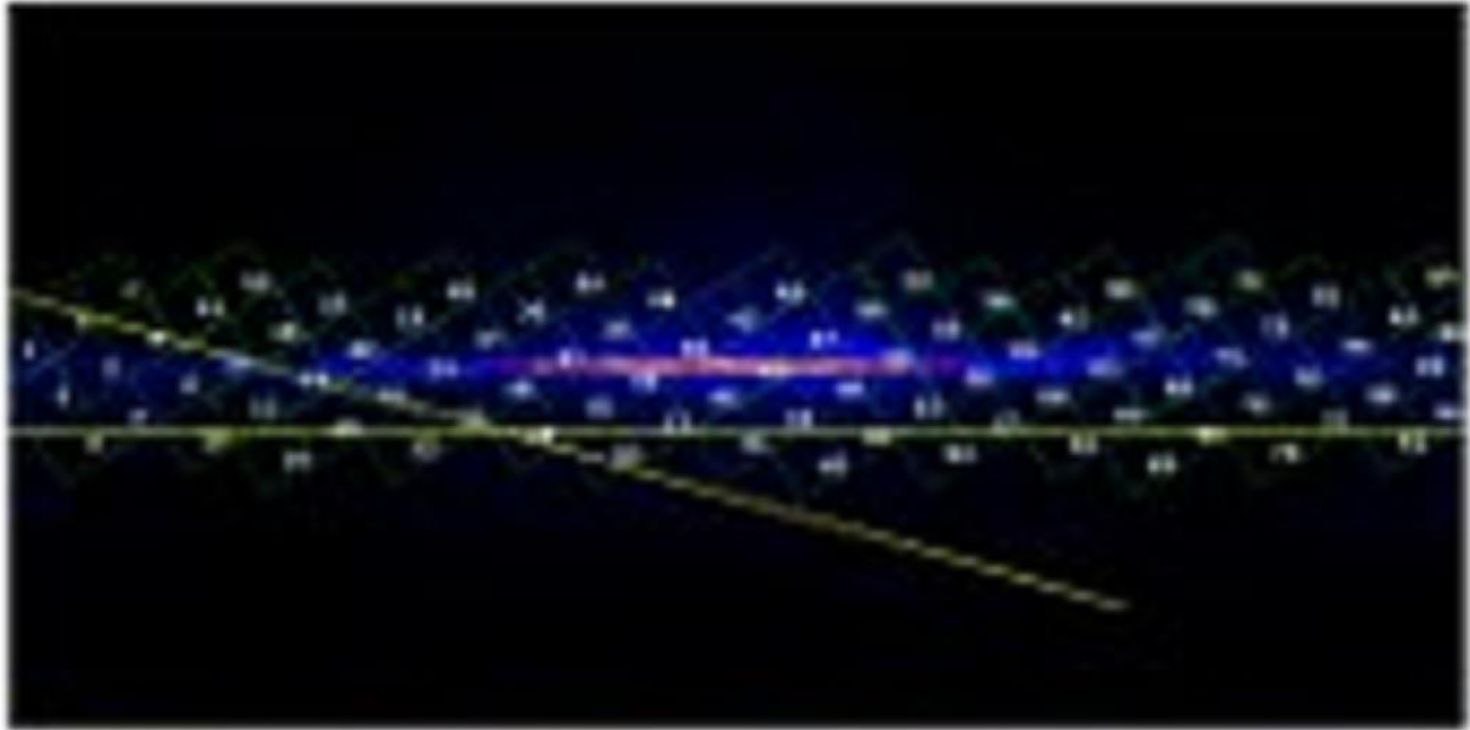
Model map



Residual map



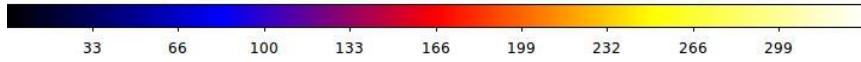
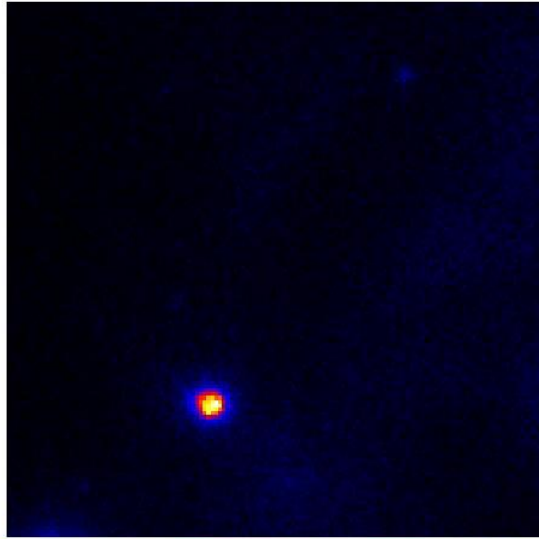
## Milky Way Galactic Plane Region Map



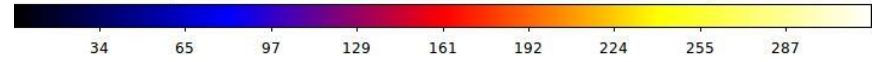
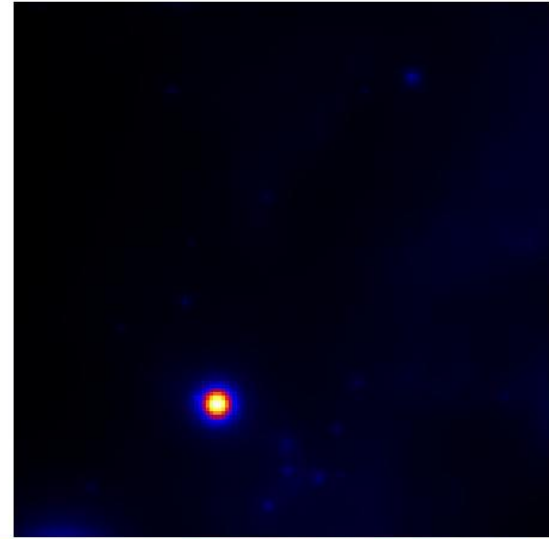
110,000 ly = 660,000 trillion miles = 990,000 trillion km

# Region 1

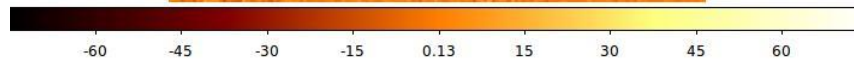
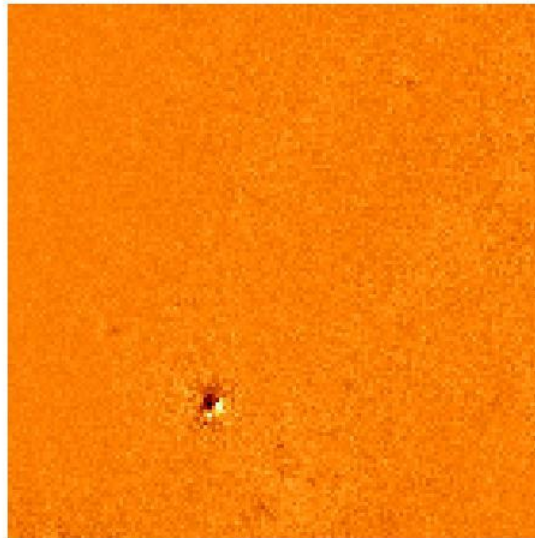
## Counts Map



## Model Map

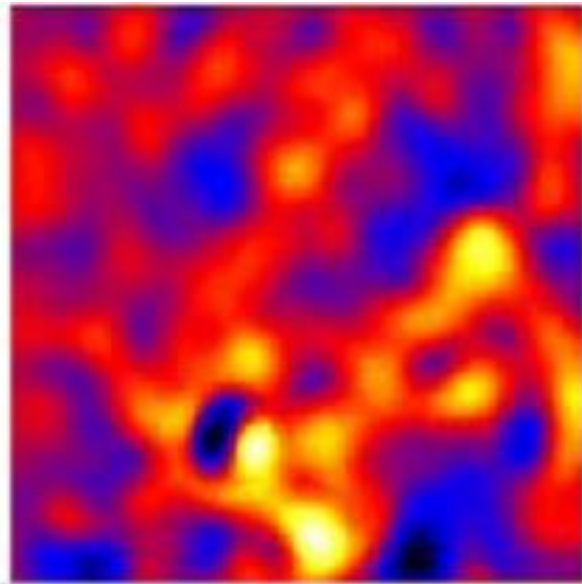


## Residual Map



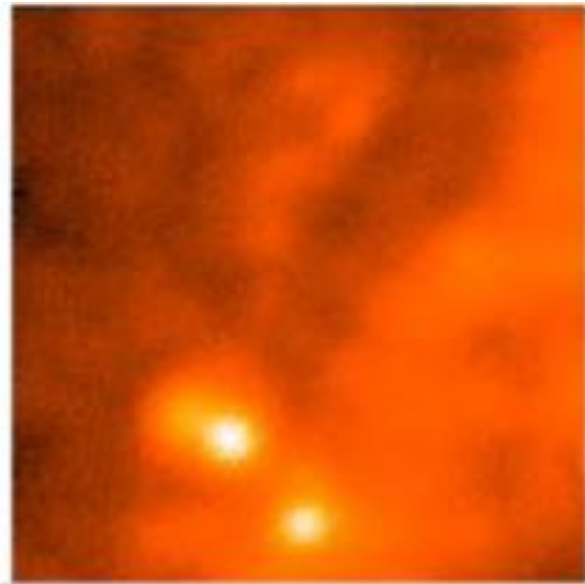
# Region 1

Smoothed Residual map



-0.2 -0.15 -0.10 -0.05 0.05 0.10 0.15 0.2

Radio WMAP



0.00 0.02 0.04 0.6 0.8 1.0 1.2 1.4





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